Coldspot Method of Pancreas Scanning

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Pancreatic scanning has been subjected to more modifications than any other nuclear medicine procedure, yet it continues to be a challenge for most nuclear medicine departments with standard instrumentation. Our method enables us to obtain consistently reliable images of high quality in routine pancreatic scanning, using a rectilinear scanner. The lowest activity area in the abdomen—the coldspot—is chosen as the scanner setup point. The light source voltage is adjusted so that coldspot is just above the lower knee (light grey) of the density curve. The selected range differential must vary with coldspot percentage of scale to achieve an equivalent of 40% suppression. These setup factors ensure high contrast and controlled background sensitivity for all pancreatic scans using a rectilinear scanner. Better enhancement of image quality is achieved by use of two overlapping films in the cassette to record the photo scans with scanning done at double speed and half-line spacing, which results in averaging of density fluctuations due to random counting rate. The second film with its filtered image gives better anatomic definition of pancreas and liver. The routine pancreatic study includes scanning at 10 min and 40 min after injection of Se-75; a Tc-99m sulfur colloid liver scan is done while the patient is in the same position.

The rectilinear scanner is often regarded as troublesome and unreliable for pancreas scanning. Some of the most common problems are unsuitable hot spot setup point, and improper film density or contrast. Additional problems, such as liver overlying the pancreas, thinning of the pancreas at the spine, high intestinal activity, and increased focal length due to obesity may be caused by the patient. These problems were evident in our scans, prompting us to try new techniques for pancreas scanning. These included enhancement techniques, scanner-to-scintillation-camera comparative analysis, and most important, a new scanner setup point on the patient—the lowest activity spot in the abdomen. The new procedure for pancreas scanning used in our department is detailed.

Materials and Methods

Preliminary Preparation. The patient fasts from midnight and the following morning receives 16 oz of skim milk. Thirty minutes after the skim milk is given, selenomethionine Se-75 (4.0 μCi/kg; 250 μCi maximum) is administered intravenously; the scan begins 10 min postinjection. The patient is positioned 10° left anterior oblique (LAO). If the patient is obese, however, he is positioned flat for anterior projection. A Picker rectilinear scanner is used with 5-in. focus, high energy, and ½-in. resolution collimator tilted 10° cephalad.

Scanner Settings. At 10 min postinjection, locate the "coldspot," i.e., lowest radioactivity response, in the abdominal area, avoiding the hip crests and bladder as they may appear colder. The coldspot appears between 20% and 60% of the 3k × 1 scale, with obese patients at 20–36%, average patients at 36–50%, and thin patients at 50–60% for our scanners. The range differential is effectively a 40% suppression. (See Discussion for coldspot range differential.) Use duration of 50, 75, or 100, 3k × 1 ratemeter range, time constant of 0.1 sec, 35 cm/min speed, dot factor 8, and background cutoff percent equal to coldspot percent. The light source voltage is set just above the lower knee of the density curve (generally 650V ± 50V). The film density is 300 for our scanner (a value that yields a light grey density over the coldest spot or about 0.4 on a densitometer). The 14 in. × 17 in. film cassettes are loaded with two films in one cassette. Double the speed to 70 cm/min and halve the line space to 0.2 cm. Scan from the top of the liver to the completion of both pancreas and liver. An optional second view is taken, at the same settings, from the bottom to the top of the liver. Finally, a Tc-99m sulfur colloid liver scan is performed with the patient in the same position. A routine liver scan is then performed on a gamma camera.

Discussion

With the patient positioned 10° LAO and the detector tilted 10° cephalad, a reasonable, sometimes excellent separation between liver and pancreas is achieved (*1*). It has been our experience that overangulation of patient or scanner probe will increase collimator-to-pancreas distance. Therefore, unless the patient is thin, overangulation will put the pancreas seriously out of focus to the collimator. For an obese patient, the collimator-to-pancreas distance is already near the 5-in. focal length of the collimator. Hence, we position obese patients in a straight anterior view with the probe 10° cephalad to minimize this distance.

The range differential or suppression setting is not determined in the usual manner when setting up on the coldest spot in the abdomen. To maintain a constant contrast comparable to 40% suppression, the range differential must vary by the amount given in Table 1. Our scanner was designed for a hotspot setup point near

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100% full scale (*2*). Our coldspot setup point varies from 20% to 60% of scale. We have observed that the contrast is affected by the setup point percent of scale. At 20%, there is considerable lowering of contrast. Thus, a correction to the range differential (Table 1) becomes necessary to achieve a constant 40% suppression for all patients. On a hotspot, i.e., highest radioactivity response, setup, the range differential yields contrast in the form of background suppression. But on a coldspot setup, the range differential causes contrast in the form of foreground enhancement.

It is not possible to wash out the background on any range differential or suppression setting when the coldspot is correctly set to a light grey 300 film density (0.4 on the densitometer). Only the foreground, i.e., high activity area, is variably darkened by changing the range differential at this setting. Thus, high contrast with controlled background sensitivity is achieved. The same constant contrast and background sensitivity from patient to patient is the result. Identical results have been described when the coldspot method has been applied to brain scanning (*3*).

Scanning is done routinely with an x-ray cassette loaded with two x-ray films. The first film layer acts as a light filter so the photoscan on the second film layer is of lighter film density and greater contrast. Bar phantom studies (Fig. 1) reveal no loss of resolution in the second film. Defocusing of the dots may occur in the second film in areas where a thin layer of air has slightly separated the two films. This technique will enhance any separation between liver and pancreas. The image on the first film is unaltered by introduction of the second film. Double film loading works equally well for gamma cameras.

TABLE 1. Range Differential Adjustment

Range Differential	Abdomen Coldspot
40	20–28%
50	29–42%
60	43–60%

Doubling the speed and halving the line space to 0.2 cm require the use of a rectangular light guide that gives a 0.4-cm line width. Each line will then evenly overlap the previous line. Each point will be scanned twice at twice the speed; the information density is not altered. Thyroid phantom studies (Fig. 2) indicate no loss in resolution; however, a defocusing of the rectangular dot is seen. Fluctuations in film density due to low counting rate fluctuations are better averaged and visually smoothed by double speed with one-half line space. The time constant should not exceed 0.1 sec to avoid significant scalloping. Scalloping will not be seen at double speed and half-line space, but the image will be degraded through the lowered contrast.

The first pancreatic image at 10 min postinjection requires about 30 min of scanning. A second pancreas view, in the reverse direction, may be done to detect any late filling of cold pancreatic areas seen on the first view. The second pancreas view may be omitted whenever a well-defined pancreas is seen on the 10-min view. A Tc-99m

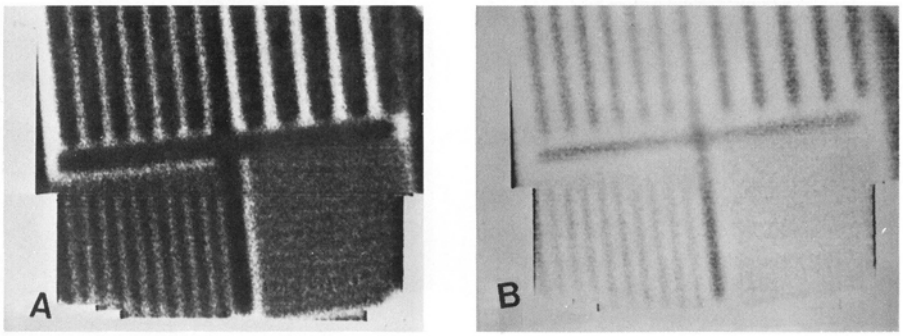

FIG. 1. Bar phantom (A) on first film layer; bar phantom (B) on second film layer.

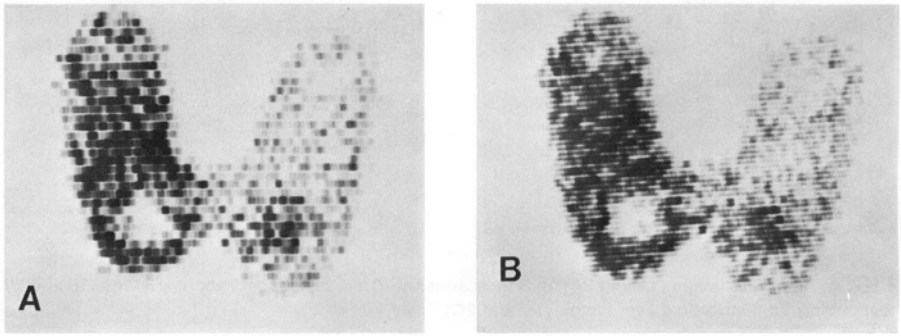

FIG. 2. Routine thyroid phantom (A) and same phantom (B) at double speed and one-half line space.

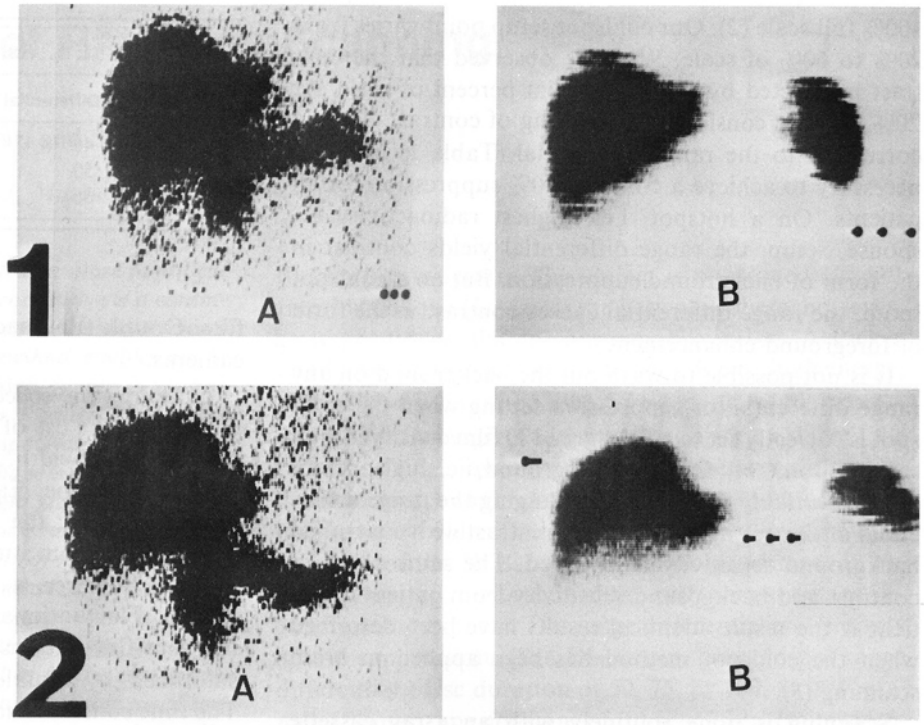

FIG. 3. Pancreas image (1A and 2A) using coldspot method on a 5-in. scanner at 10 min post dose and corresponding Tc-99m colloid liver image (1B and 2B).

sulfur colloid liver scan is then performed while the patient is still in the same position. Finally, a liver–spleen scan is performed on a gamma camera.

These techniques are adaptable to any commercial scanner now in use. It is important, however, to use no less than a 5-in. focusing high-energy collimator. Use of a collimator with less focal depth will yield an out-of-focus pancreas for all but thin patients, thus missing some positive defects. For most nuclear medicine departments, it should just require taking the time to experiment and establish coldspot film density and contrast parameters to use the coldspot method of pancreas scanning.

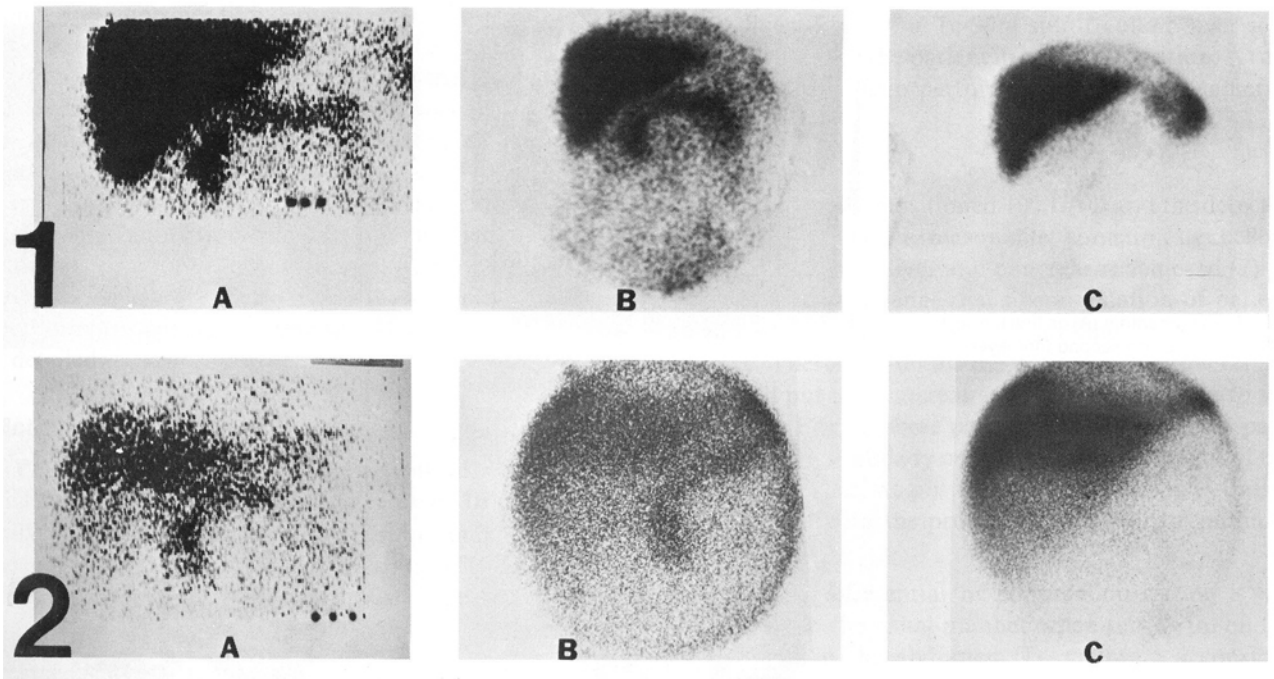

FIG. 4. Pancreas image (1A and 2A) on 5-in. scanner at 10 min post dose. Pancreas image (1B and 2B) on Picker 2C Camera at 40 min post dose. Corresponding Tc-99m colloid liver image (1C and 2C).

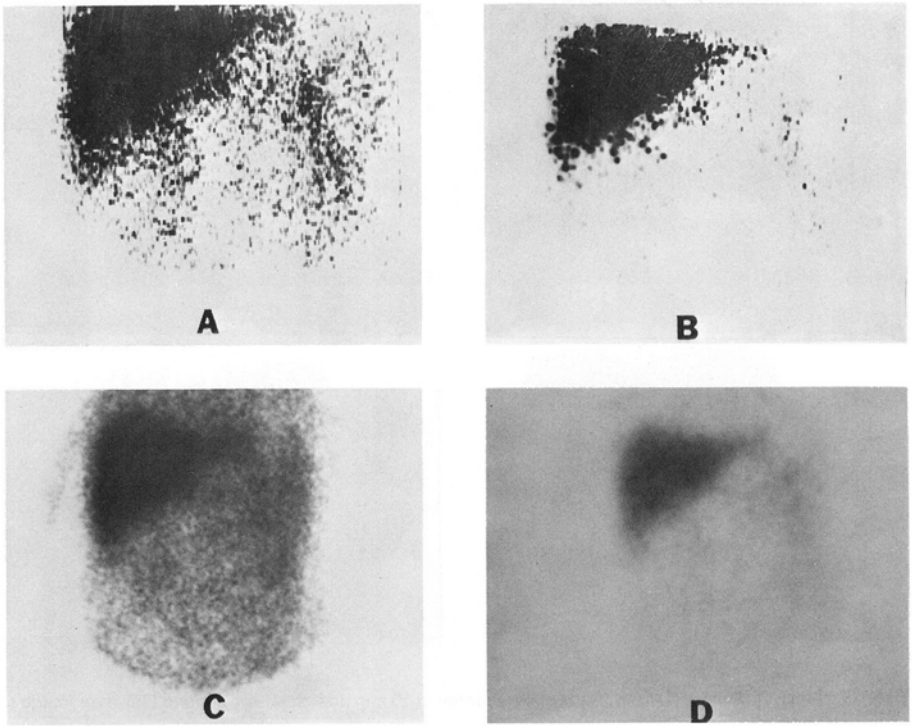

FIG. 5. Pancreas image (A) on 5-in. scanner at 10 min post dose and second film layer image (B). Pancreas image (C) on Picker 2C camera at 45 min post dose and second film layer (D). Corresponding Tc-99m colloid liver image (E).

Data and Results

The preceding techniques have been used at our medical center for over 900 pancreas scans to date. The normal pancreas scanner image shows good contrast with the patient's intestinal background activity (Fig. 3). Pancreas images from Anger cameras have fair-to-good contrast but the intestinal background is more prominent than in those seen on comparative scanner images (Fig. 4). When visualizing medium-to-low pancreatic uptake, the camera is clearly inferior to the scanner (Fig. 5). Intestinal background activity and low contrast on

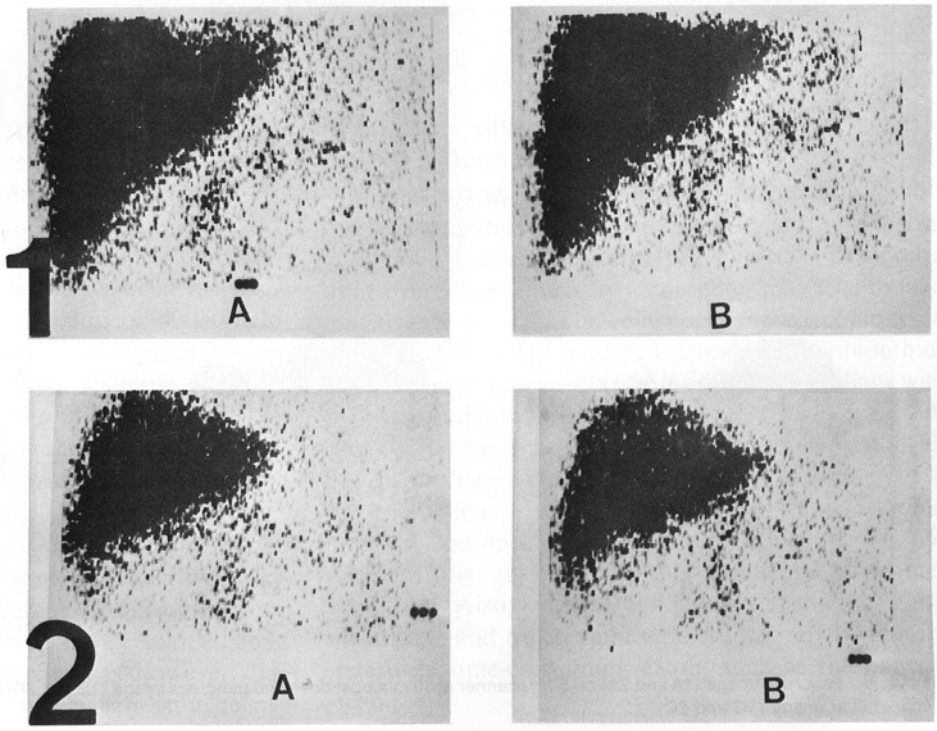

FIG. 6. Pancreas image (1A and 2A) on 5-in. scanner at 10 min post dose and pancreas image (1B and 2B) at 40 min post dose.

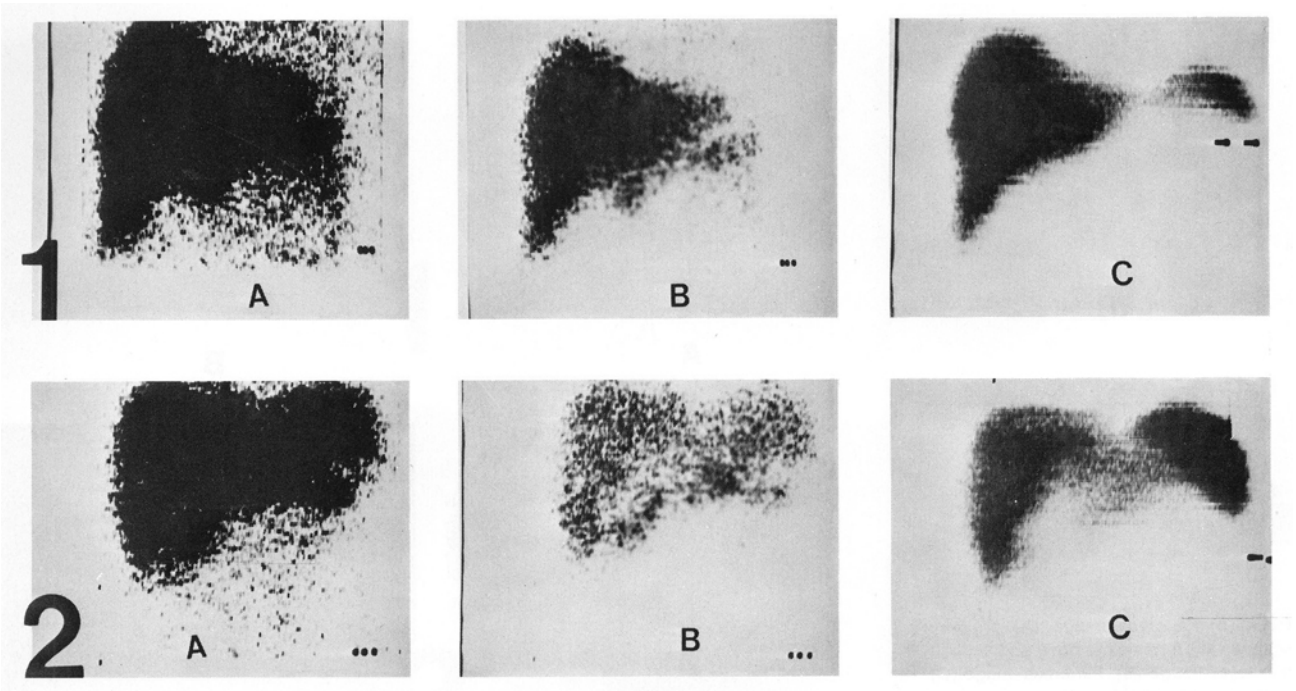

FIG. 7. Pancreas image (1A and 2A) on 5-in. scanner at 10 min post dose and second film layer image (1B and 2B). Corresponding Tc-99m colloid liver image (1C and 2C).

scintillation camera images can obscure visualization of the pancreas, whereas controlled background sensitivity with high contrast allows the scanner to visualize even the faintest pancreatic uptake of tracer as in the case of pancreatitis (Fig. 6). With the coldspot method of setup, display of an overly dark pancreas or liver can only be due to high tracer uptake. The contrast and film density are set over the abdomen and, therefore, liver and pancreas activities do not affect the scanner settings, which yield identical contrast and background density

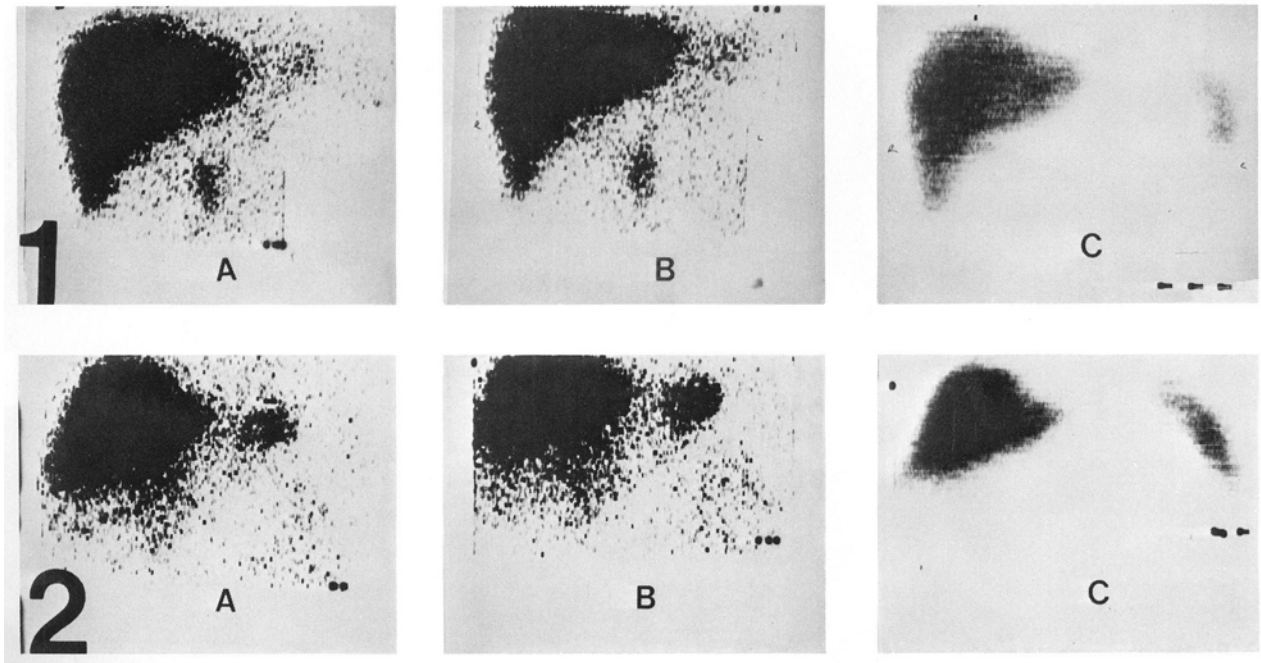

FIG. 8. Pancreas image (1A and 2A) on 5-in. scanner at 10 min post dose and pancreas image (1B and 2B) at 40 min post dose. Corresponding Tc-99m colloid liver image (1C and 2C).

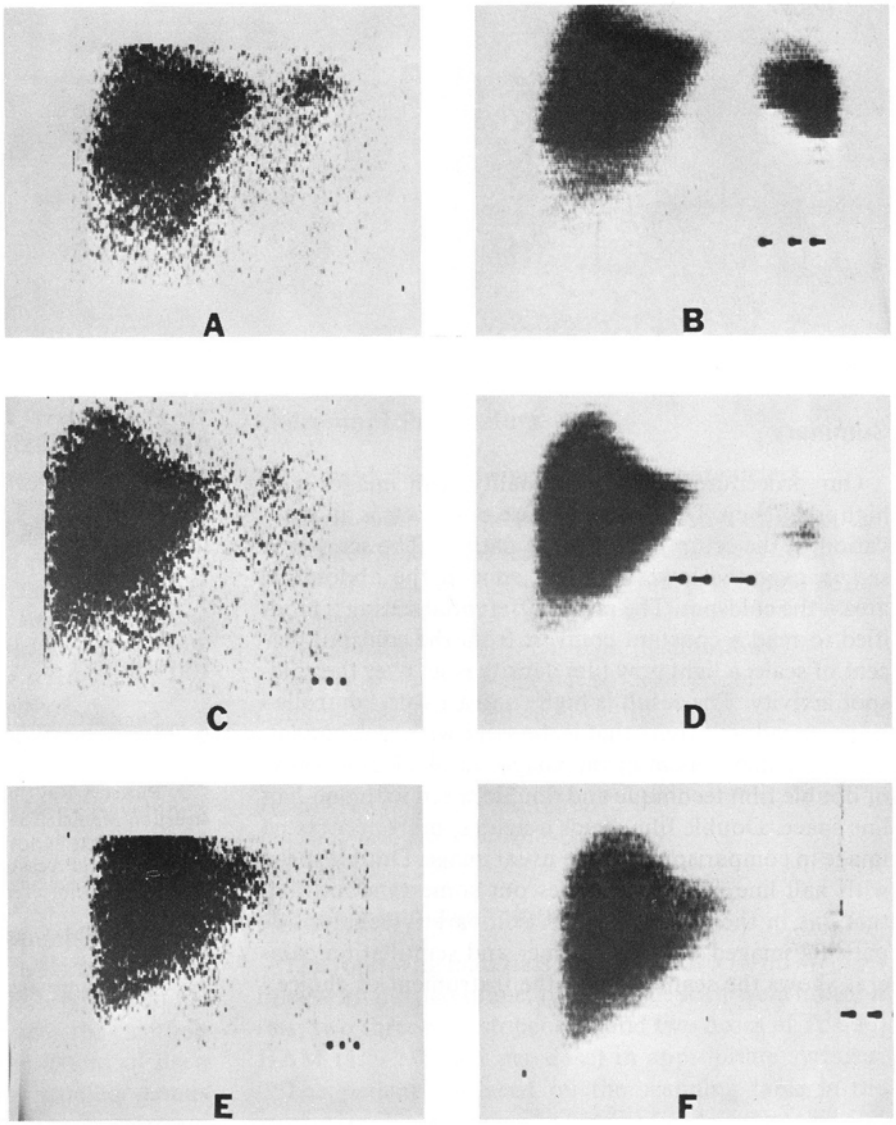

FIG. 9. Initial scan: pancreas image (A) and Tc-99m colloid liver image (B); second scan: pancreas image (C) and Tc-99m colloid liver image (D) at three months after first scan; and third scan: pancreas image (E) and Tc-99m colloid liver image (F) at six months after first scan.

for all patients. An extremely dark pancreas may be difficult to distinguish from the liver, which is usually overexposed. This problem occurs infrequently and is always solved by the use of two x-ray films in one cassette (Fig. 7). The second film layer is lighter and higher in contrast, thus enhancing any separation between the liver and pancreas. The double film technique will also help to define a pancreas that is slightly overlapped by the liver (Fig. 7). The coldspot method is simple, reliable, and successful for a wide spectrum of patients. For the case of a space-occupying lesion, the coldspot method clearly displays the cold areas, while the surrounding pancreatic tissue is well visualized (Fig. 8).

Reproducibility of the coldspot method's contrast and background sensitivity is demonstrated when one patient is scanned on three different occasions (Fig. 9). The liver and abdomen film density have remained constant on all three occasions. The pancreas, however, displays decreasing film density, which can only be attributed to advanced pathology and not to variable scanner settings.

Figure 10 [*Medical Radioisotope Scintigraphy*] shows how a computer can smooth out data and add contrast to better enhance the pancreas (*4*). However, Rejali warns that overenhancement by a computer may lead to false-positive defects (*4*). The coldspot scanner techniques we present cause only moderate contrast and smoothing, and yield optimum visualization on the first image without videotape replay or rescanning at new settings. An analysis of the first 720 coldspot scans reveals that the scanner achieves visualization of the pancreas 89% of the time. Previous to this, our scintillation cameras, which are not equipped with computers, achieved only 66% visualization, thus making the scanner the instrument of choice. Also, cameras and computers are better used in cardiac and other more vital studies rather than in a relatively time-consuming exam, such as the pancreas scan.

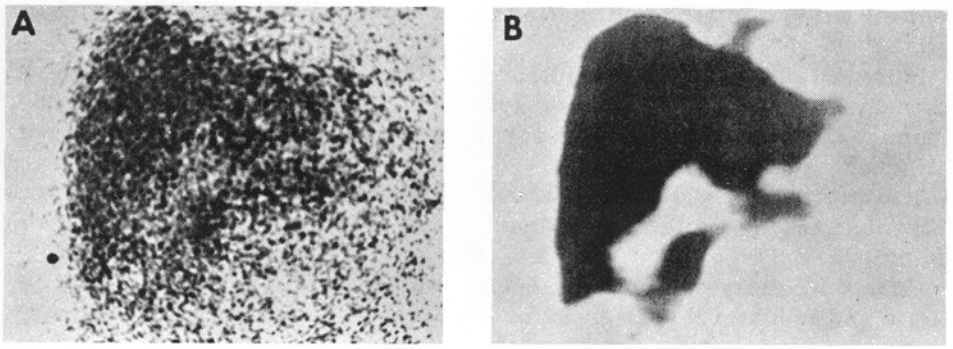

FIG. 10. Original unaltered gamma camera pancreas image (A); and computer-enhanced image (B). [With permission of the International Atomic Energy Agency.]

Summary

Our procedure yields high-quality scan images with high frequency. The primary cause of success is an innovation of the setup point on the patient. The scanner is set up over the lowest activity spot in the abdominal area—the coldspot. The range differential setting is modified to read a constant contrast from the coldspot percent of scale; a light grey film density is set over the coldspot activity. The result is high contrast with controlled background sensitivity that is the same with each patient. Further enhancement of the images results from the use of double film technique and double speed with one-half line space. Double film yields a lighter, more contrasted image in comparison with the usual image. Double speed with half-line spaces smoothes out some random fluctuations in the film density. A comparative analysis of patients imaged on both scanner and scintillation cameras shows the scanner to be the instrument of choice.

Acknowledgments

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